Движение тела, брошенного под углом к горизонту с учётом сопротивления воздуха

$\text{appVersion}(3) = \text{"1.2.9018"}$

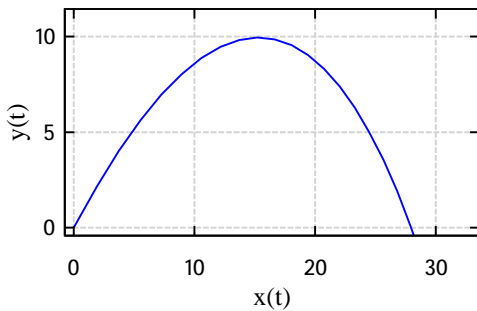$k := 0.2 \quad \alpha := 50\,° \quad steps := 20$

$v_0 := 20 \quad m := 1 \quad g := 9.8$

$\text{rkfixed}("?") = \begin{array}{l}\text{"rkfixed(cmd)} \\ \text{rkfixed(ode,y(x),xmax)} \\ \text{rkfixed(ode,y(x),xmax,steps)} \\ \text{rkfixed(ics,xmin,xmax,steps,D(x,y))"}\end{array}$

Вариант 1

$D(t, u) := \text{stack}\left(u_3, u_4, -k \cdot \dfrac{u_3}{m}, -g - k \cdot \dfrac{u_4}{m}\right)$

$u_0 := \text{stack}\left(0, 0, v_0 \cdot \cos(\alpha), v_0 \cdot \sin(\alpha)\right)$
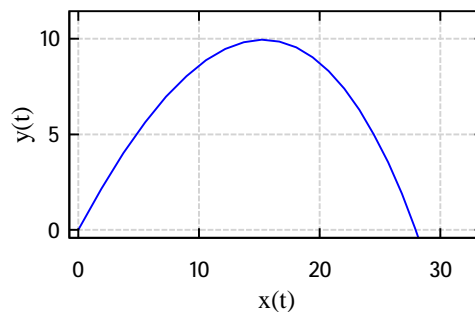
$u := \text{rkfixed}\left(u_0, 0, 3, steps, D\right)$

$u_{[1..\text{rows}(u)]}\begin{bmatrix}2\\3\end{bmatrix}$

Вариант 2 $\qquad \text{Clear}\left(t, u, x(t), y(t), vx(t), vy(t)\right) = 1$

$t := \text{col}(u, 1)$

$\begin{cases} x(0) = 0 \quad y(0) = 0 \\ vx(0) = v_0 \cdot \cos(\alpha) \\ vy(0) = v_0 \cdot \sin(\alpha) \\ x'(t) = vx(t) \\ y'(t) = vy(t) \\ vx'(t) = -k \cdot \dfrac{vx(t)}{m} \\ vy'(t) = -g - k \cdot \dfrac{vy(t)}{m} \end{cases}$

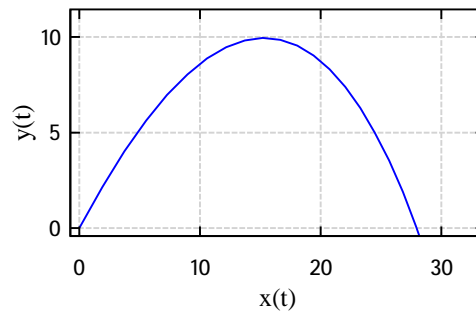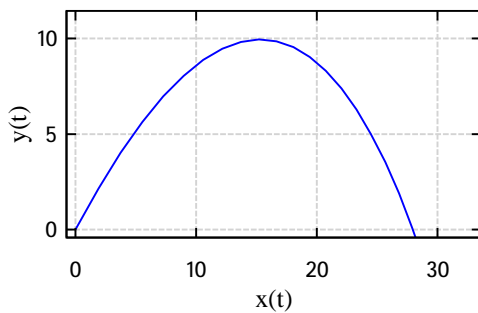$\begin{bmatrix} x(t) \\ y(t) \end{bmatrix}$

$u := \text{rkfixed}\left(\begin{cases} x(t) \\ y(t) \\ vx(t) \\ vy(t) \end{cases}, 3, steps\right)$

Вариант 3 $\text{Clear}\big(t\,,u\,,x\,(t)\,,y\,(t)\,,vx\,(t)\,,vy\,(t)\big)=1$

$$t:=\text{col}\,(u\,,1)$$

$$\begin{cases} x\,(0)=0 \quad y\,(0)=0 \\ x'\,(0)=v_0\cdot\cos(\alpha) \\ y'\,(0)=v_0\cdot\sin(\alpha) \\ x''\,(t)=-k\cdot\dfrac{x'\,(t)}{m} \\ y''\,(t)=-g-k\cdot\dfrac{y'\,(t)}{m} \end{cases}$$

$$u:=\text{rkfixed}\left(\begin{cases} x\,(t) \\ y\,(t) \end{cases},\,3\,,\text{steps}\right)$$

$$\begin{bmatrix} x\,(\mathbf{t}) \\ y\,(\mathbf{t}) \end{bmatrix}$$

Вариант 4 $\text{Clear}\big(t\,,u\,,x\,(t)\,,y\,(t)\,,vx\,(t)\,,vy\,(t)\big)=1$

$$ode:=\begin{cases} x\,(0)=0 \\ y\,(0)=0 \\ x'\,(0)=v_0\cdot\cos(\alpha) \\ y'\,(0)=v_0\cdot\sin(\alpha) \\ x''\,(t)=-\dfrac{k\cdot x'\,(t)}{m} \\ y''\,(t)=-\dfrac{g\cdot m+k\cdot y'\,(t)}{m} \end{cases}$$

$$u:=\text{rkfixed}\left(ode\,,\begin{cases} x\,(t) \\ y\,(t) \end{cases},\,3\,,steps\right)$$

$$t:=\text{col}\,(u\,,1)$$

$$\begin{bmatrix} x\,(\mathbf{t}) \\ y\,(\mathbf{t}) \end{bmatrix}$$